

FDG-PET/CT appearance of injected silicone particles (VOX® Implants) in head and neck tissues

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Summary. *Objectives:* In head and neck surgery, Positron Emission Tomography/Computed Tomography imaging (FDG-PET/CT) is often used to identify primary tumor site in patients with unknown primary carcinoma, to predict response after chemoradiotherapy and in some cases, to detect recurrence. To rehabilitate swallowing after surgery in patients with persistent dysphagia, an injectable suspension of silicone (VOX® Implants) can be used to reduce the gaps in the neoglottis. The purpose of this report is to document the PET appearance of PDMS in a series of 3 patients who underwent partial laryngectomy with subsequent VOX® Implants injection. *Material and methods:* A retrospective chart and imaging review was performed at our institution. Three patients were identified and included in the study. Appearance of PDMS at PET was described and discussed. *Results:* An increased uptake of 2-fluoro-2-deoxy-D-glucose (FDG) was noticed at PET in all patients. *Conclusions:* The increased uptake was possibly due to active inflammatory reactions that are necessary for tissue integration of textured silicone particles. (www.actabiomedica.it)

Key words: Positron Emission Tomography/Computed Tomography, partial laryngectomy, silicone

Introduction

The aim of partial laryngectomy is to perform a radical removal of the neoplasm, reconstructing the anatomical crossing of the respiratory and digestive tracts with the recovery of laryngeal functions (1). Although functional problems are improved with speech therapy in the majority of cases, in some patients, persistent dysphagia due to neoglottic incontinence can lead to recurrent aspiration pneumonia, inadequate food intake and compromised quality of life (2-3).

In recent years, the use of silicone (polydimethylsiloxane [PDMS]) injections has been reported in the literature as an option in surgical rehabilitation

of swallowing in patients who have undergone partial laryngectomy (4).

Our department initially started using this material for injection thyroplasty in vocal fold paralyses (5). The absence of side effects and the enduring nature of the results encouraged us to use this material as a filler in persistent swallowing problems after partial laryngectomy. When some gaps or excessive spaces form in the neoglottis, this material is injected as a filler to close those spaces. This allows better swallowing performance, less risk of aspiration and penetration of food or saliva (6).

Of course, just like other patients operated for head and neck squamous cell carcinoma (HNSCC),

patients who had partial laryngectomies are regularly followed-up. Positron Emission Tomography/Computed Tomography (PET/CT) imaging is increasingly being used in follow-up, to predict the response in the primary site and in the neck after chemoradiotherapy but also, in some cases, to diagnose recurrence (7). The interpretation of images in patients with complex laryngeal reconstructions can be very challenging for radiologists, and this can be further complicated by the presence of "foreign" material. The purpose of this report is to document the PET appearance of PDMS in a series of 3 patients who underwent partial laryngectomy with subsequent VOX® Implants injection. To our knowledge this is the first study reporting PDMS appearance in PET.

Material and methods

A retrospective chart and imaging review of patients who underwent VOX® Implants injections and subsequently CT/PET scan was performed.

PET/CT images were acquired at the same institution (University Hospital of Modena, Nuclear Medicine Department) with an integrated PET/CT device (GE, Discovery LSA, Milwaukee, Wisconsin, USA) composed of an Advance NXi PET scanner and a 16-slice LightSpeed Plus CT scanner. At the time of 2-fluoro-2-deoxy-D-glucose (FDG) administration, plasma glucose levels were in the normal range. To avoid artifacts caused by muscle activity, the patient was instructed not to undertake any physical activity or to talk before the examination. The images were acquired approximately 50 min after injection of 37 MBq/10 kg FDG. The patient was instructed to breathe normally. CT data were used for attenuation correction of PET scanning that was performed immediately after acquisition of the CT images, without changing the patient's position. CT acquisition was performed without iodine contrast medium administration. PET images were acquired caudo-cranially with 3D interactive reconstruction.

The PET images were evaluated qualitatively (visual inspection) and semiquantitatively using the FDG-PET standardized uptake value (SUV).

Results

Three patients were finally included. Clinical history is herein summarized, and imaging PET/CT findings were further discussed.

Patient 1

A 77 years old male patient, underwent partial laryngectomy with cricohyoidopexy and monolateral neck dissection in 2009 for pT4a R0 pN0 M0 (AJCC stage IVA) laryngeal squamous cell carcinoma. Despite the stage of the disease, no adjuvant radiotherapy was performed as a result of the pathological nodal stage N0 and clear margins, and the possible impact of radiotherapy on functional outcome and the general condition of the patient.

The patient started swallowing rehabilitation during his hospital stay and therapies continued after patient discharge. However, after an adequate and prolonged swallowing rehabilitation, the dysphagia persisted and provoked aspiration pneumonia and inadequate food intake.

At the fibrotic endoscopic evaluation of swallowing (FEES) boluses of different consistencies were tested to identify the incorrect routes for the passage of food or the presence of food accumulation regions. The patient then underwent surgical rehabilitation with PDMS injection during suspension microlaryngoscopy under general anesthesia. From the results of the FEES, PDMS (VOX® Implants) (2 to 3 ml) was injected into the right base of the tongue and to the omolateral neoglottic region. No postoperative complications were noted and a significant improvement in dysphagia was obtained.

After 1 year, a contralateral nodal recurrence was diagnosed and the patient underwent contralateral neck dissection followed by chemoradiotherapy ending in May 2011. During oncological follow-up with the appearance of two lung micronodularities, PET/CT imaging was performed.

The images did not show any accumulation in the lung, but showed increased metabolism in the right basal tongue (Figure 1) with a SUV of 4.5.

With regard to this abnormal accumulation, the images were discussed at a multidisciplinary team

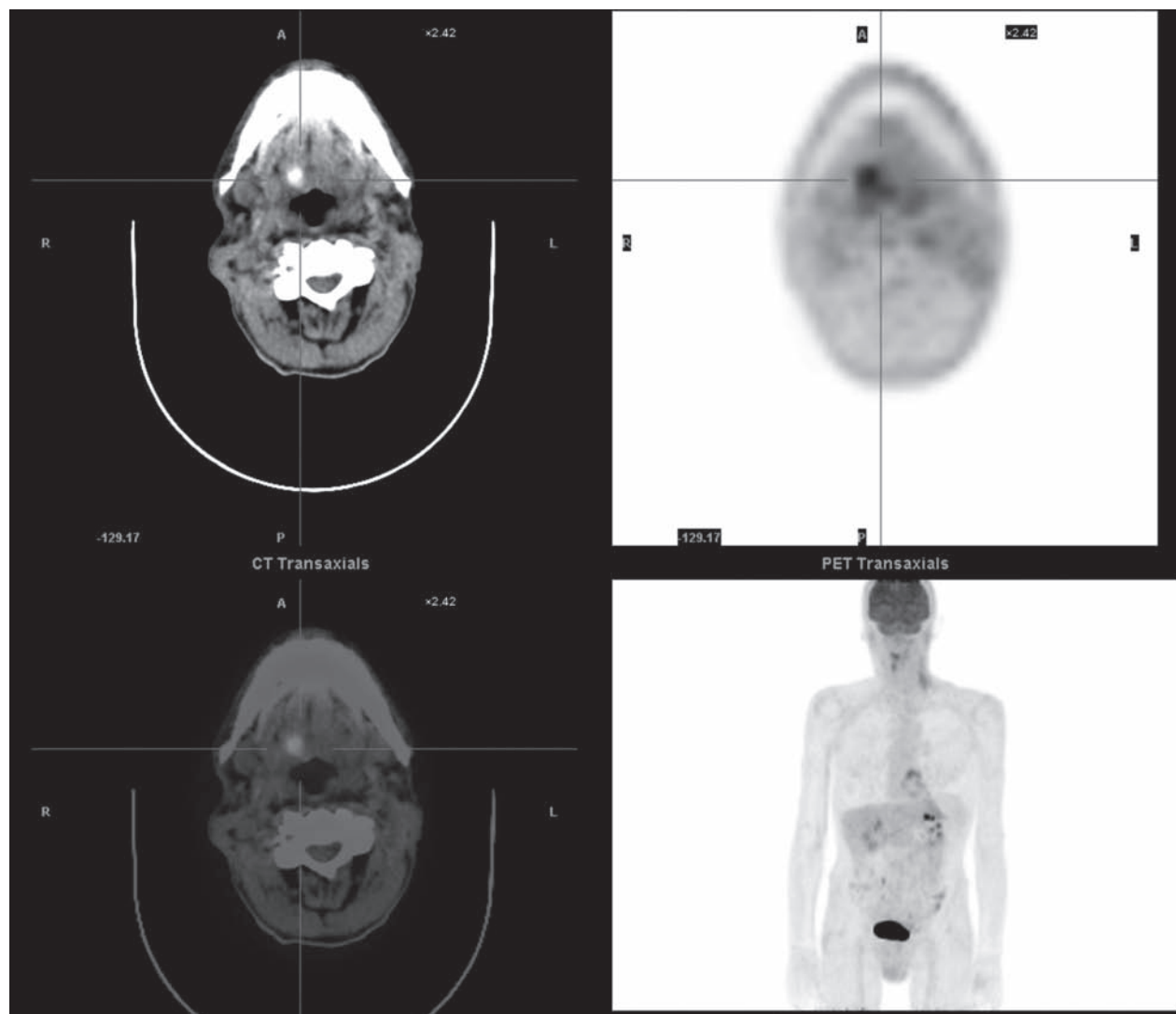


Figure 1. Axial slices of PET/CT show increased activity in the right basal tongue indicated by the lines. The image in the lower right corner shows a three-dimensional volume display with increased activity at the same point in the axial slices

meeting composed of the otolaryngologist, radiologist, oncologist and radiotherapist. After an initial suspicion of recurrence of the tumor, a hypothesis was considered whereby the increased uptake could be due to the PDMS injection. In fact, a complete correspondence was noted between the regions of increased metabolism and the sites of injection as described by surgical reports and earlier MR images. No biopsy was performed to confirm this hypothesis, but further MRI was conducted 3 months after these findings and confirmed the stability of the area with no suspected tumor reappearance and documented a slight hypoin-

tensity of the signal in T1-weighted images in agreement with the MRI appearance of PDMS (Figure 2).

Patient 2

A 80 years old male patient underwent multiple suspension microlaryngoscopy for recurrent leucoplachias during several years in another hospital. He also performed a left laser cordectomy in 2009. Due to multiple operations and to the cordectomy, his glottis had an important glottic gap during phonation, with a consequent marked dysphonia, an a short phona-

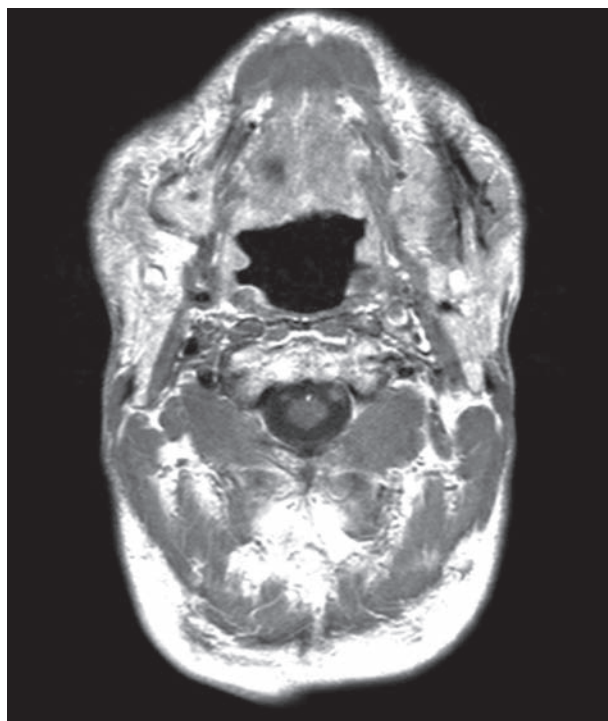


Figure 2. MR T1-weighted axial image of the basal tongue shows a slight hypointensity of the signal in the right basal tongue according to the site indicated by PET/CT

tion time. After one year from the cordectomy, since he was free from disease at the clinical evaluation, an operation of PDMS-VOX® Implants injections was performed to reduce glottic gap and improve voice performances, with satisfactory results.

In the meanwhile, he was diagnosed to have a lymphoma, and he started therapies and clinical and instrumental exams for that. At two PET/CT, a marked hyper-accumulating region was detected in the left vocal cord (SUV n.a.) (Figure 3). At a fibre-optic evaluation the glottis showed no disease. Based on the experience of previous case, we decided to avoid biopsies, and we only recommended a close follow-up. During following years, the patient did not developed any laryngeal neoplasm, and at a further PET/CT for the lymphoma, the finding was again detected, almost unmodified. The patients is still in follow-up for its laryngeal condition, although its clinical and radiological history were deemed quite reassuring to present authors.

Patient 3

A 64 years old male underwent in 2012 a partial laryngectomy (cricohyoidopexy) for squamous cell carcinoma of the glottic and supraglottic region in another hospital. The patient started swallowing rehabilitation during his hospital stay and therapies continued after patient discharge. However, after an adequate and prolonged swallowing rehabilitation, an important post-operative dysphagia persisted and provoked aspiration pneumonia and inadequate food intake. He also had aspiration pneumonia, and a had PEG placement.

A fibrotic endoscopic evaluation of swallowing (FEES) was performed at our hospital with boluses of different consistencies to identify the incorrect routes for the passage of food or the presence of food accumulation regions. The patient then underwent surgical rehabilitation with PDMS injection during suspension microlaryngoscopy under general anesthesia. From the results of the FEES, PDMS (VOX® Implants) (2 to 3 ml) was injected into the right base of the tongue and to the omolateral neoglottic region. No postoperative complications were noted and an improvement of his symptoms was reported. Nonetheless, at the follow-up period in the following months, a recurrence of his dysphagia manifested again. A PET was performed to exclude a recurrence the base of the tongue; the PET showed a hyper-accumulation of FDG (SUV max 10.2) (Figure 4). An operation on biopsy of the base of the tongue and revision of the pexy was planned. At the histologic examination of the specimen obtained from the base of the tongue, no squamous cell carcinoma was found, and a “giant cell granulomatous inflammation in close relationship to a foreign body” was described (Figure 5). The finding was consistent with the inflammation related to VOX® Implants injection. After a temporary improvement of his dysphagia, he is still having problems

Discussion

Silicone already has many applications in medicine and surgery because of its well-known stability and tolerance in human tissues. The material used in the case reported was VOX® Implants (Bioplasty BV,

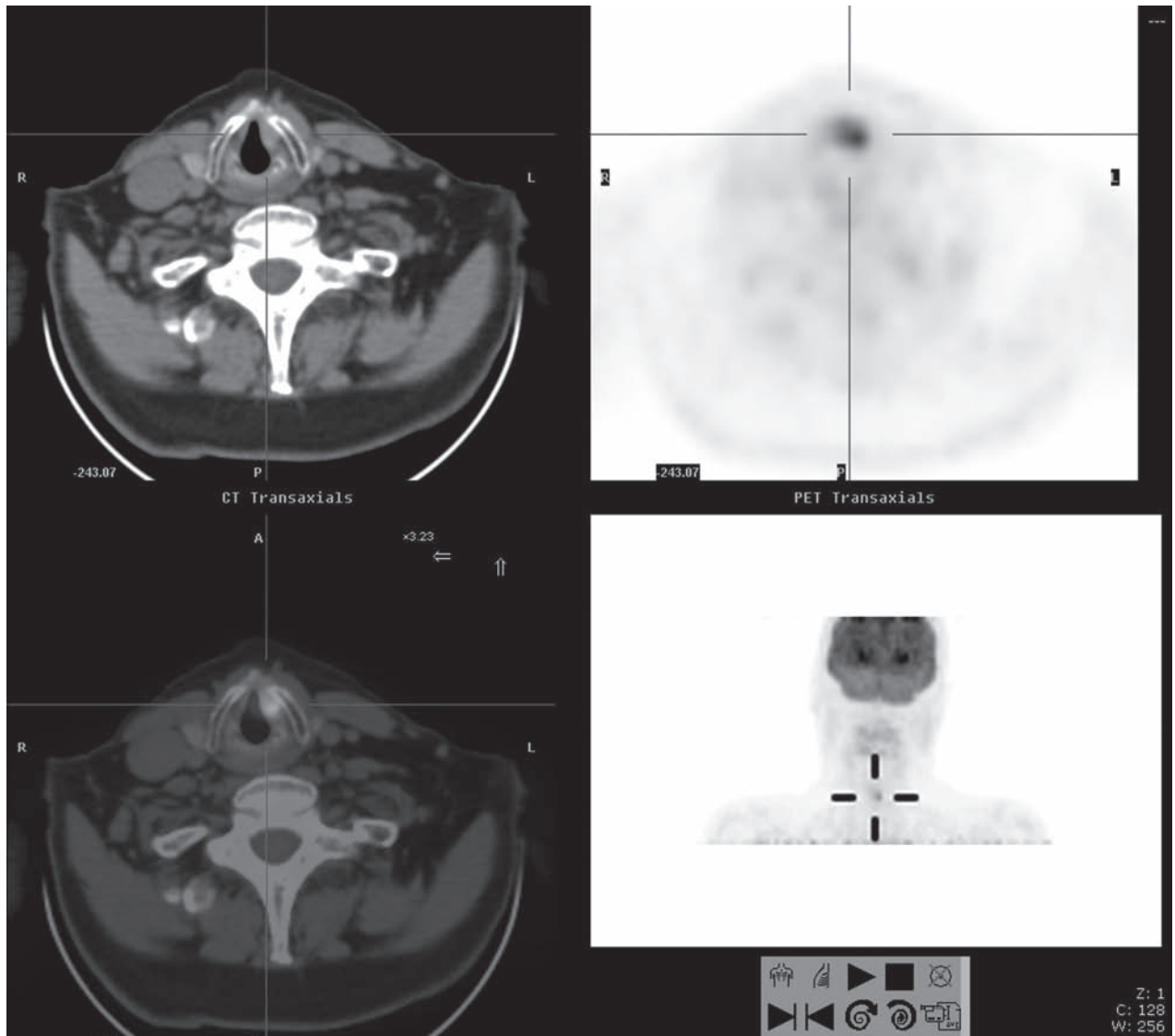


Figure 3. Axial slices of PET/CT show increased activity in the right basal tongue indicated by the lines. The image in the lower right corner shows a three-dimensional volume display with increased activity at the same point in the axial slices

Hofkamp 2, 6161 DC Geleen, The Netherlands): this is an injectable suspension of solid textured granules of an elastomer of PDMS, with a particle diameter between 100 and 200 μm , suspended in a hydrogel of polyvinylpyrrolidone. The diameter of the particles avoids distant migration from the site of injection, while texturization facilitates mechanical bonds between particles and host tissues favoring the formation of a fibrous envelope around the particles, and making the tissue augmentation stable and long lasting (8).

Although the MRI appearance of silicone prosthetic implants has been extensively reported in the literature, particularly with regard to breast implants (9), in our earlier study (10) dealing with the MR appearance of PDMS, we documented that that T2-weighted images appeared particularly useful in the early stages after injection due to the clear hyper-intensity of the signal; this hyper-intensity seems to gradually attenuate with time, switching to an iso-hypointensity. This is consistent with histological data obtained in

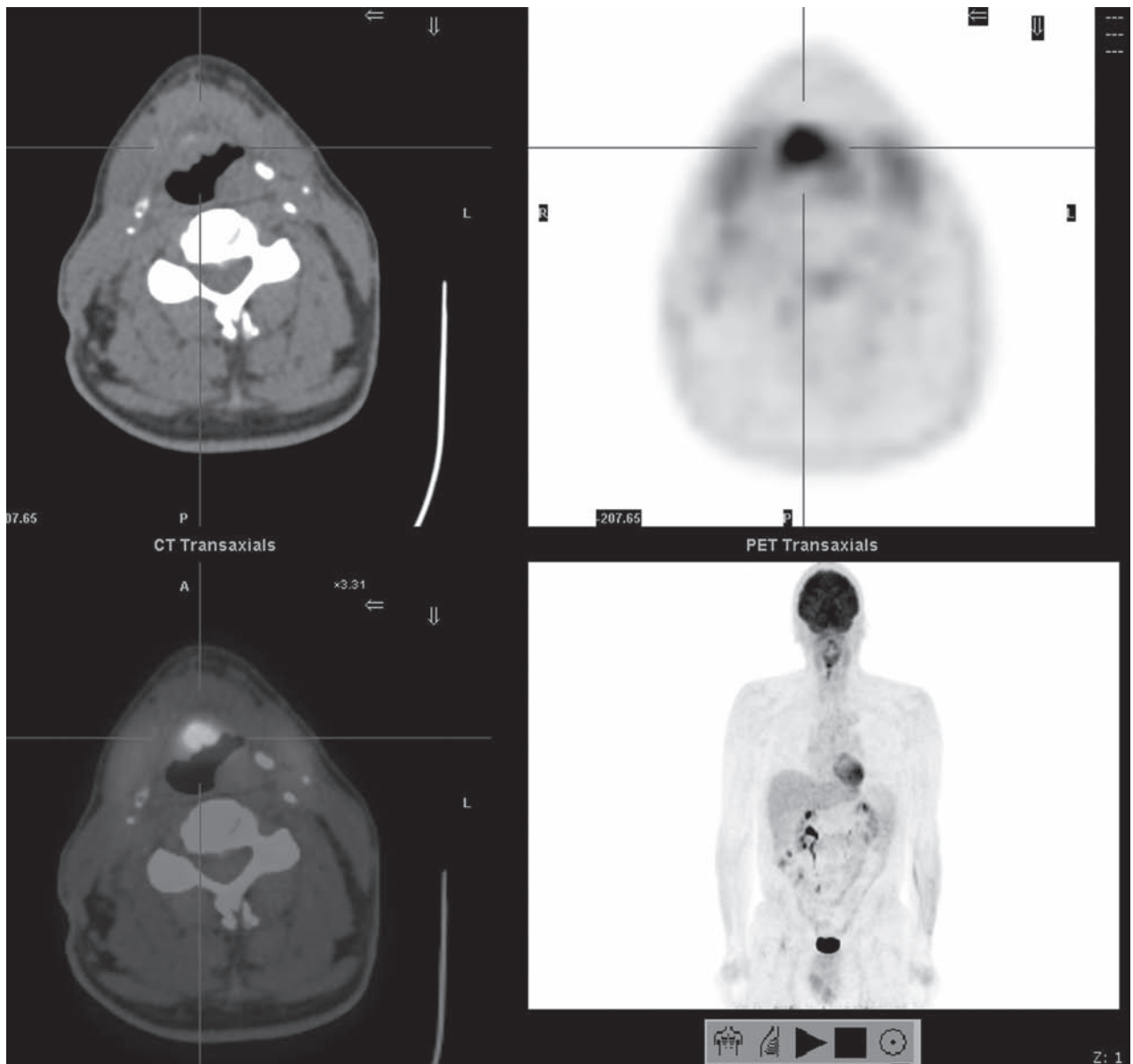


Figure 4. Axial slices of PET/CT show increased activity in the right basal tongue indicated by the lines. The image in the lower right corner shows a three-dimensional volume display with increased activity at the same point in the axial slices

some studies (11,12) where it is documented that the PDMS gradually integrates with tissue, forming a fibrous envelope.

Integration of PDMS with tissue may be reflected not only in changes in MRI appearance as previously reported, but also in increased uptake in PET images. A possible reason for this appearance could be the integration process of the PDMS with the tissue, which may trigger an inflammatory mechanism. As is well

known, inflammatory tissue has an increased metabolism and this could be the basis for the increased uptake of PDMS in PET images in our patients.

We could support the hypothesis that even after a partial integration of PDMS with tissues, inflammation around the material probably continues even during several years with a remodeling process with inflammatory activity so intense to be detected at PET. In fact, a giant cell inflammation was found on the his-

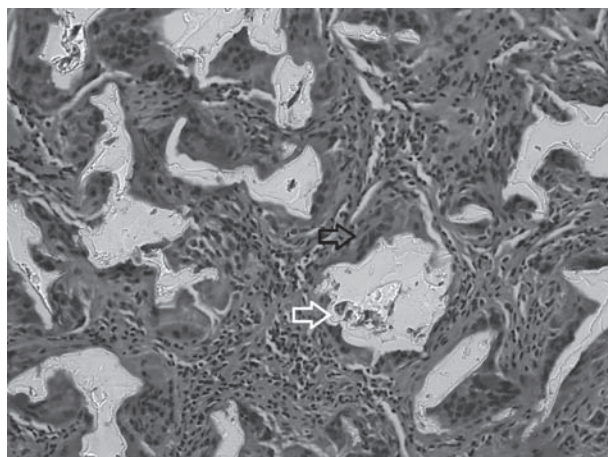


Figure 5. Giant cell (black arrow) granulomatous inflammation in close relationship to a foreign body material (white arrow)

tologic specimen obtained in patient 3, and this finding could support the hypotheses.

Few studies have documented the injection-laryngoplasty imaging appearance and there are no studies to our knowledge in English literature that have documented the PET appearance of this material. In our opinion, radiologists, ENT specialists, and also oncologists and radiotherapists involved in the follow-up of head and neck cancer and in particular, of laryngeal cancer, may benefit from knowledge of the image characteristics and variability in appearance of this material so as to improve image interpretation. This could result also in different attitude in patient management, for example a more conservative attitude when other clinical findings are reassuring, and a more precise counseling with patients about the nature of PET findings.

Conclusion

At CT/PET, PDMS injected regions can give an hyper-accumulation of FDG. This is likely due to the hyper-metabolism of those regions provoked by chronic mild inflammatory process. Knowledge of this characteristics could improve images interpretation possibly modifying patient management and counseling.

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Received: 8 December 2014

Accepted: 16 April 2015

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